E-ISSN: 2618-0618
P-ISSN: 2618-060X

www.agronomyjournals.com
2024; SP-7(10): 233-236
Received: 10-07-2024
Accepted: 16-08-2024

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Evaluation of red pumpkin (*Cucurbita moschata* duch ex. Poir) genotypes for growth, yield and quality

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DOI: https://doi.org/10.33545/2618060X.2024.v7.i10Sd.1752

Abstract
The present investigation entitled "Evaluation of red pumpkin (*Cucurbit moschata* Duch Ex. Poir.) genotypes for growth, yield and quality" was conducted during the period from *kharif* 2022 at All India Coordinated Research Project on Vegetable Crops, Mahatma Phule Krishi Vidyapeeth, Rahuri. The experiment was laid out in Randomized Block Design with three replications and ten genotypes with two standard check variety Arka Chandan and Arka Suryamukhi. The main objectives of the experiment were to evaluate the genotypes for growth, yield and quality characters of fruits. The analysis of variance revealed that mean sum of squares due to genotypes was highly significant for all characters like length of vine (m), number of primary branches per vine, days required for appearance of first male flower, days required for appearance of first female flower, number of male and female flowers per vine (sex ratio), days required for first harvest of fruits, number of fruits per vine, average weight of fruit (kg), length of fruit (cm), fruit diameter (cm), fruit yield (t/ha), fruit flesh thickness (cm), number of ridges per fruit, seed cavity length (cm), seed cavity width (cm), number of seeds per fruit, 100 seeds weight (g), T.S.S. (°Brix), β- carotene (mg/100g), downy mildew, powdery mildew and fruit fly. From overall performance of all the genotypes it can be concluded that the genotypes T_{10}: 3X4 - 4-2-2-5-5-3, T_8: 3X4 - 3-5-3-4-2-18 and T_3: 1X2 - 7-6-2-9-20-9 showed better performance for growth, yield and yield contributing characters. Hence, selection of this genotypes for further evaluation could beneficial for improvement in red pumpkin. Thus study clearly indicate that favourable varieties could be developed with earliness, more number of fruits per vine, more flesh thickness coupled with high carotene content in pumpkin fruits suitable for neutraceticals industry.

Keywords: Genotypes, yield, growth, quality, β- carotene

Introduction
Cucurbitaceous crops are the largest group of vegetables grown in India and throughout the world. Pumpkin (*Cucurbita moschata* Duch Ex. Poir) is one of the important cultivated cucurbits originated from Central Mexico and has a place of high value, due to its long shelf life, high productivity, excellent response to forcing, high nutritive value especially carotene content. Fruits of pumpkin can be used as vegetable both in immature and mature stage. Mature fruits can be used in preparing sweets, jams and also can be candied or fermented to prepare a beverage. Fruit flesh is delicious when stewed, boiled or baked.

Cucurbitaceae is one of the largest families in vegetable kingdom consisting of largest number of edible species. There are 27 species under the genus Cucurbita, five of which are in cultivation. These are *Cucurbita moschata*, *Cucurbita maxima*, *Cucurbita ficifolia*, *Cucurbita pepo* and *Cucurbita mixta*. *Cucurbita moschata* is commonly known as pumpkin and widely cultivated species of Cucurbita and the fruit is valued for its long storage capacity and high nutritious value (Jahan *et al.*, 2012) [4]. The yellow and orange fleshed fruits are very rich in carotene (3,332 IU), which is precursor of Vitamin-A with fair quantities of vitamins B and C. It may contribute to improve the nutritional status of the people, particularly the vulnerable groups with respect to vitamin A requirement (Satkar *et al.*, 2013) [11]. In India, pumpkin is cultivated over an area of 10900 ha, with a total production of 2299 MT (Anon., 2021-22) [1]. The pumpkin produced in India is mainly used for domestic consumption as fresh vegetable. The mature fruits, apart from the main use as vegetables, are also utilized as industrial raw material for carotene production (Vucetic *et al.*, 1989) [15]. Pumpkin, as pulp powder is exported in a limited

volume. A vast scope exists for increasing the production and export of pumpkin to enhance foreign exchange.

Pumpkin has recently gained industrial importance due to the development of pulp powder as a nutritional supplement to Vitamin 'A' requirements. Pumpkin is a less expensive source of Vitamin A than carrot, which has specific climatic requirements for production and high productivity per unit area. The pumpkin grown in India is primarily consumed as a fresh vegetable. Pumpkin pulp powder is exported in small quantities. There is a lot of room to increase pumpkin production and exports in order to boost foreign exchange. Pumpkin fruit has good source of β-carotene which is the major precursor of vitamin-A. The carotenoid found in red pumpkin fruits are α-carotene, β-carotene and lutein, which gives colour to the fruits. The total carotenoids content in red pumpkin was 12.12 mg/100 gm of pulp. The concentration of these major carotenoids were α-carotene 5.15 mg/100 gm, β-carotene3.10 mg/100 gm and lutein1.50 mg/100 gm. The major quantum of fruit contains 92.6% moisture, 4.6% carbohydrates, 1.4 g protein 0.1 g fat, 0.06 mg thiamine, 0.0 mg riboflavin, 2 mg vitamin C, 10 mg calcium and 0.7 mg iron in 100 g.

In pumpkin the major problem in consumer preference is large sized fruits (4-5 kg) which is not much preferred by a small family of three to four members. Further, with increased number of nuclear families of recent scenario in India, people prefer to buy only small to medium sized whole fruits of pumpkin instead of cut pieces. Further, the small fruits can be easily packed and transported without any damage. Hence, development of pumpkin varieties and hybrids with small to medium sized fruits (2-3 kg) is essential. Several attempts were made both by public and private sectors to develop high yielding varieties and hybrids. However, development of high yielding varieties and hybrids coupled with medium sized fruits having high beta carotene content is very meager. Pumpkin has received little attention in crop improvement, as compared to other Cucurbitaceous vegetables. Since ancient times, a wide number of germplasms are available, conscious evaluation and exploitation of germplasm has not been attended until recently. This is very helpful for a plant breeder in developing a commercial variety with market preference by determining the component characters on which selection can be exercised based on the improvement in yield and quality. Preliminary identification of early maturing genotypes can be done based on characters like days to opening of female flowers, node number to first female flowering and days to fruit picking.

Materials and Methods

This investigation entitled "Evaluation of Red pumpkin (*Cucurbita moschata* Duch Ex. Poir) genotypes for growth, yield and quality" was conducted during the period of *Kharif* 2022 at All India Coordinated Research Project on Vegetable crops, Department of Horticulture, Mahatma Phule Krishi Vidyapeeth, Rahuri. The experimental material comprised of 10 genotypes and 2 check hybrid of red pumpkin maintained at the All India Coordinated Research Project on Vegetable Crops, Department of Horticulture, Mahatma Phule Krishi Vidyapeeth, Rahuri.

Genotypes	
T_1	1X2 - 2-7-3-4-9-1
T_2	1X2 - 7-1-1-5-4-1
T_3	1X2 - 7-6-2-9-20-9
T_4	2X3 - 1-3-1-7-13-18
T_5	2X3 - 7-1-3-6-1-16
T_6	3X4 - 2-2-6-9-20-8
T_7	3X4 - 3-1-1-3-6-3
T_8	3X4 - 3-5-3-4-2-18
T_9	3X4 - 3-11-2-5-16-17
T_{10}	3X4 - 4-2-2-5-5-3
T_{11}	Arka Chandan (Check)
T_{12}	Arka Suryamukhi (Check)

The experiment was laid out in Randomized Block Design with three replications. The observations were recorded for all characters like length of vine (m), number of primary branches per vine, days required for appearance of first male flower, days required for appearance of first female flower, node at which first female flower appeared, number of male and female flowers per vine (sex ratio), days required for first harvest of fruits, number of fruits per vine, weight of fruit (g), length of fruit (cm), diameter of fruit (cm), yield per hectare (t), number of ridges per fruit, seed cavity length (cm), seed cavity width (cm), number of seeds per fruit, 100 seeds weight, T.S.S. ^{0}Brix, β-carotene, downy mildew, powdery mildew, fruit fly incidence of fruit. The data collected on different parameters during the course of investigation were subjected to statistical analysis as per method of analysis of variance (Panse and Sukhatme, 1985) [8].

Result and Discussion

Growth character: The maximum vine length was recorded in the genotype T_{10} (4.63 m) which was at par with T_6 (4.21 m) and T_3 (4.09 m) and minimum vine length was recorded in check variety Arka Suryamukhi (2.47 m) and among the genotypes minimum vine length was recorded in T_8 (3.22 m). The maximum number of primary branches per vine was recorded in genotype T_9 (4.60) which was at par with genotype T_6 (4.43) and T_3 (4.40). The lowest number of primary branches per vine was recorded in genotype T_1 (3.85).Similar results were reported by Ingole *et al.,* 2022 [3] and Verma *et al.,* 2023 [14].

Flowering characters: Among the genotypes minimum days for appearing of first male flower was recorded in T_{10} (49.90 days) followed by genotype T_8 (50.06 days) and T_3 (50.50 days). Genotype T_9 (51.56 days) takes maximum days to appear first male flower. Minimum days to first female flower emergence was recorded among genotypes in T_{10} (54.06 days) whereas the maximum days (56.06 days) were registered in T_9. Genotype T_{10} recorded lowest node (12.88) for first female flower opening whereas T_7 observed at highest node (16.33). Lowest sex ratio (Male: Female flowers) was observed in genotype T_{10} (14.93) which was at par with genotypes T_3 (15.23), T_1 (15.60), T_6 (16.05) and T_9 (16.39). Among the pumpkin genotypes, T_{10} displayed minimum number of days (105.43 days) to first

harvest from days after sowing followed by T_6 (105.46 days) T8 (105.50 days) whereas maximum duration for first harvest was recorded for T_9 (107.11 days). Such variation was reported by Krishnamoorthy *et al.*, 2016, Ingole *et al.*, 2022 [3] and Verma *et al.*, 2023 [14] in pumpkin genotypes.

Yield characters: Among the genotypes T_{10} (4.05 fruits per vine) shows maximum number of fruits per vine which followed by genotypes T_8 (3.76 fruits per vine), (3.72 fruits per vine) and genotype T_7shows minimum number of fruits per vine (3.06 fruits per vine). The highest average fruit weight was found T_{10} (4.10 kg) which was at par with T_8 (4.07 kg), T_2 (4.05 kg) and lowest among genotypes in T_1 (3.22 kg). Maximum fruit length was recorded T_{10} (26.36 cm), which was at par with T_5 (24.37 cm), T_6 (24.36 cm). The minimum length of fruit was recorded in T_8 (17.13 cm) and lowest in check Arka Suryamukhi (11.23 cm) and Arka Chandan (15.83 cm). Minimum fruit diameter among genotypes was recorded in T_2 (17.07 cm) and check Arka Suryamukhi (14.90 cm) shows lowest fruit diameter of fruit. Significantly maximum fruit diameter recorded in genotypes T_{10} (25.61 cm), which was at par with T_5 (24.40 cm). Highest yield per hectare found in genotype T_{10} (33.21 t/ha) was statistically superior, which was at par with T_8 (30.96 t/ha) and T_3 (29.10 t/ha). Check Arka Suryamukhi (13.66 t/ha) shows minimum fruit yield of pumpkin per hectare and among genotypes was recorded in T_7 (21.10 t/ha). Similar results were in accordance with Darshini *et al.*, 2021 [2], Ingole *et al.*, 2022 [3] and Verma *et al.*, 2023 [14] in pumpkin.

Quality Parameters: Maximum flesh thickness was recorded in genotype T_{10} (4.00 cm) which was at par with T_8 (3.72 cm) and T_3 (3.50 cm). Minimum flesh thickness was observed among genotypes in T_1 (2.87 cm). The genotype T_{10}recorded maximum ridges per fruit (13.66) whereas the genotype T_6 recorded lowest ridges per fruit (9.33). The maximum seed cavity length was found in T_{10} (19.13 cm) which is at par with genotypes T_5 (18.23 cm), T_6 (18.20 cm) and lowest in genotype T_7 (11.36 cm). The maximum seed cavity width was found in T_{10} (19.49 cm) which was at par with genotypes T_5 (19.27 cm), T_3 (18.50 cm) and minimum in genotype T_6 (13.03 cm). The maximum number of seeds per fruit was recorded in genotype T_{10} (431.33) and minimum number of seeds per fruit was recorded in genotype T_4 (306.00). Maximum 100 seed weight in genotype T_{10} (15.10 g) whereas minimum seed weight was observed in genotype T_3 (9.27 g). Maximum T.S.S. was recorded in genotype T_{10} (9.36 ^{o}Brix). However, the genotype T_5 (6.23 ^{o}Brix) recorded for minimum T.S.S. Maximum amount of β-carotene was found in genotype T_{10} (6.56 mg/100 g) which is at par with genotypes T_3 (6.45 mg/100 g) β-carotene content. The lowest level of β-carotene was recorded in genotype T_8 (4.68 mg/100g).The similar findings was also recorded by Thirumdasu and Chatterjee, 2018 [13] and Ingole *et al.*, 2022 [3].

Table 1: Performance of Red pumpkin genotypes for growth and flowering characters

Genotypes	Growth characters		Flowering character				
	Length of vine (m)	Number of primary branches per vine	Days to 1st male flower appearance	Days to 1st female flower appearance	Node number at which 1st female flower appear	Sex ratio per vine	Days to first harvest
T_1: 1X2 - 2-7-3-4-9-1	3.78	3.85	50.70	55.00	13.13	15.60	106.37
T_2: 1X2 - 7-1-1-5-4-1	3.83	4.07	51.24	55.74	13.77	17.23	107.11
T_3: 1X2 - 7-6-2-9-20-9	4.09	4.40	50.50	55.10	13.13	15.23	106.47
T_4: 2X3 - 1-3-1-7-13-18	3.50	4.04	50.26	55.03	14.87	16.95	106.39
T_5: 2X3 - 7-1-3-6-1-16	3.96	4.03	50.22	55.18	15.33	17.76	106.65
T_6: 3X4 - 2-2-6-9-20-8	4.21	4.43	50.76	54.30	14.20	16.08	105.46
T_7: 3X4 - 3-1-1-3-6-3	3.45	4.21	50.73	54.98	16.33	18.05	105.66
T_8: 3X4 - 3-5-3-4-2-18	3.22	4.20	50.06	54.66	15.00	15.19	105.50
T_9: 3X4 - 3-11-2-5-16-17	3.90	4.60	51.56	56.03	15.43	16.39	107.56
T_{10}: 3X4 - 4-2-2-5-5-3	4.63	4.16	49.90	54.06	12.88	14.93	105.43
T_{11}: Arka Chandan (C)	3.56	3.81	41.55	46.15	12.73	14.94	97.51
T_{12}: Arka Suryamukhi (C)	2.47	4.22	46.14	50.70	15.33	18.04	102.07
GM	3.56	4.30	49.47	53.91	14.26	16.36	105.18
S.E.m (±)	0.19	0.24	1.02	0.81	0.29	0.60	1.45
C.D. @ 5%	0.57	0.73	3.07	2.43	0.87	1.80	4.29

Table 2: Performance of Red pumpkin genotypes for yield and quality characters

Genotypes	Yield character					Quality character			
	Number of fruits per vine	Weight of Fruit (kg)	Length of fruit (cm)	Diameter of fruit (cm)	Yield per hectare (ton)	Fruit flesh thickness (cm)	Number of ridges per fruit	Seed cavity length (cm)	Seed cavity width (cm)
T_1: 1X2 - 2-7-3-4-9-1	3.63	3.22	21.17	20.23	23.43	2.87	12.00	15.43	15.50
T_2: 1X2 - 7-1-1-5-4-1	3.18	4.05	17.47	17.07	25.80	3.47	11.33	14.30	13.90
T_3: 1X2 - 7-6-2-9-20-9	3.72	3.91	21.13	23.50	29.10	3.50	12.33	15.13	18.50
T_4: 2X3 - 1-3-1-7-13-18	3.34	3.23	20.77	19.80	21.64	2.93	11.67	15.03	15.07
T_5: 2X3 - 7-1-3-6-1-16	3.13	3.98	24.37	24.40	25.04	3.47	12.00	18.23	19.27
T_6: 3X4 - 2-2-6-9-20-8	3.53	3.85	24.36	18.20	27.19	3.46	9.33	18.20	13.03
T_7: 3X4 - 3-1-1-3-6-3	3.06	3.43	23.40	19.23	21.10	3.30	11.00	17.20	14.03
T_8: 3X4 - 3-5-3-4-2-18	3.76	4.07	17.13	20.03	30.96	3.72	12.16	11.36	15.26
T_9: 3X4 - 3-11-2-5-16-17	3.38	3.36	21.26	21.73	22.65	3.06	10.66	15.56	17.03
T_{10}: 3X4 - 4-2-2-5-5-3	4.05	4.10	26.36	25.61	33.21	4.00	13.66	19.13	19.49
T_{11}: Arka Chandan (C)	4.71	1.96	15.83	18.33	23.21	2.76	11.66	10.30	13.80
T_{12}: Arka Suryamukhi (C)	6.59	0.83	11.23	14.90	13.66	1.83	8.66	7.56	12.23
GM	3.84	3.33	20.54	20.40	24.75	3.20	11.37	14.70	15.56
S.E.m (±)	0.15	0.16	0.78	0.82	1.84	0.10	0.43	0.61	0.84
C.D. @ 5%	0.45	0.48	2.29	2.43	5.54	0.30	1.28	1.83	2.47

Table 3: Performance of Red pumpkin genotypes for quality characters, diseases and pest

Genotypes	Quality characters				Diseases		Pest
	Number of seeds per fruit	100 seed weight (g)	T.S.S. (ºBrix)	β-carotene (mg/100g)	Downey mildew	Powdery mildew	Fruit fly
T_1: 1X2 - 2-7-3-4-9-1	390.67	11.49	9.07	6.37	15.37 (23.08)	8.27 (16.71)	17.93 (25.05)
T_2: 1X2 - 7-1-1-5-4-1	407.67	12.12	8.03	6.23	15.27 (23.00)	8.26 (16.70)	17.80 (24.95)
T_3: 1X2 - 7-6-2-9-20-9	430.33	9.27	9.13	6.45	13.37 (21.45)	8.22 (16.66)	16.50 (23.97)
T_4: 2X3 - 1-3-1-7-13-18	306.00	10.92	8.90	5.47	14.01 (21.98)	8.38 (16.83)	14.70 (22.54)
T_5: 2X3 - 7-1-3-6-1-16	419.67	12.80	6.23	5.62	14.25 (22.18)	8.29 (16.73)	16.31 (23.82)
T_6: 3X4 - 2-2-6-9-20-8	365.33	13.93	7.36	5.24	14.66 (22.51)	8.42 (16.86)	16.48 (23.96)
T_7: 3X4 - 3-1-1-3-6-3	323.66	9.96	8.70	4.90	12.39 (20.61)	8.24 (16.68)	15.23 (22.97)
T_8: 3X4 - 3-5-3-4-2-18	399.00	14.76	8.20	4.68	10.80 (19.19)	8.58 (17.03)	14.167 (22.11)
T_9: 3X4 - 3-11-2-5-16-17	315.33	12.40	7.36	5.18	10.27 (18.69)	8.11 (16.55)	13.13 (21.25)
T_{10}: 3X4 - 4-2-2-5-5-3	431.33	15.10	9.36	6.56	10.26 (18.68)	8.12 (16.53)	12.97 (21.11)
T_{11}: Arka Chandan (C)	186.66	9.46	8.73	4.18	11.16 (19.52)	8.80 (17.25)	17.31 (24.59)
T_{12}: Arka Suryamukhi (C)	122.66	8.90	10.23	4.02	11.45 (19.78)	8.51 (16.96)	16.09 (23.65)
GM	341.52	11.76	8.44	5.41	20.89	16.79	23.331
S.E.m (±)	5.60	0.53	0.24	0.05	0.06	0.15	0.13
C.D. @ 5%	16.44	1.60	0.73	0.15	0.17	NS	0.37

*Figures in the parenthesis are Arc sin transfer values

Percent incidence of pest and diseases: Minimum per cent incidence of Downey mildew recorded in genotype T_{10} (10.26%) which was at par with T_9 (10.27%)). The per cent incidence of powdery mildew was observed ranged from 8.11 to 8.58. Incidence of powdery mildew is recorded non-significant in all the genotypes. The genotype T_{10} (12.97%) was found significantly least infestation of the fruit fly which was at par with the genotypes T_9 (13.13%). The maximum infestation observed in T_1 (17.93%). These results were analogus with reported by Maheshwari *et al.*, 2015 [6], Roshana *et al.*, 2015 and Pal *et al.*, 2017 [7] in Cucurbits.

Conclusion

From the findings of this overall evaluation of all the genotypes it can be concluded that the genotypes T_{10}: 3X4 - 4-2-2-5-5-3, T_8: 3X4 - 3-5-3-4-2-18 and T_3: 1X2 - 7-6-2-9-20-9 showed better performance for yield and yield contributing characters. Hence, selection of this genotypes for further evaluation could beneficial for improvement in red pumpkin.

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